CRYOCOOLER REDUNDANCY CONSIDERATIONS FOR LONG-LIFE SPACE MISSIONS

R.G. Ross, Jr.
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California 91109

High reliability is a key requirement of most long-life space missions. One means of achieving high reliability with cryogenic payloads involving cryocoolers is to incorporate redundancy, either in the form of redundant coolers and/or redundant drive electronics. To access the redundant elements, electrical and/or heat switches must also be incorporated. Although the redundant elements protect against a possible failure, the increased system complexity and increased cryogenic load associated with the incorporation also have a negative effect on reliability that must be taken into account.

This paper presents an analysis of the reliability advantages and disadvantages of a variety of cryocooler redundancy options, based on their total reliability, mass, and power impact at the cryogenic system level.

The paper begins with developing an approach for quantifying the probability of failure of the key components, such as coolers, electronics, and heat switches, associated with the redundancy; the analysis considers the component's state of development, the complexity and testability of its critical failure mechanisms, and the effect of the total cryogenic load on the reliability. Means are also presented for estimating the total cryogenic load as influenced by the addition of the redundant elements.

Finally, the overall system performance (reliability, mass, and power) of the various cryocooler redundancy options is computed using the failure probabilities of the individual elements, and the system interrelationships of the elements.

Ronald G. Ross, Jr.
Jet Propulsion Laboratory
M/S 157-316
4800 Oak Grove Dr.
Pasadena, CA 91109

Phone (818) 354-9349
FAX (818) 393-4206

Prefer Oral Paper

rgrossjr@mail1.jpl.nasa.gov